Filled in

Chapter 4 Notes – Roots and Powers

DOUBLE ENTRY NOTETAKER

Look through pages 202 – 249 in your textbook. As you read make notes on things you think you know. Does a word or phrase look familiar? Have you seen some of the symbols before? Do you remember doing similar questions in the past? Also, while you read jot-down things that you may be wondering. Perhaps a specific term is unfamiliar and you'd like to know what it means. Or something your read leaves you wanting to know more. Write it down.

What I think I know….	What I wonder…

4.2 – NUMBER SYSTEMES AND APPROXIMATING IRRATIONALS (p. 207)

Natural numbers, N, are all positive integers starting at 1

ie. N = {1, 2, 3, . . . } "counting numbers"

Whole numbers, W or No, are all positive integers and 0.

ie. W = {0, 1, 2, 3, . . . }

Integers, Z (sometimes ±), are whole numbers and their opposites.

ie. Z = {. . . -2, -1, 0, 1, 2, . . . } (positive and negative whole #s + 0)

Rational numbers, Q, are any numbers written in the form of a fraction, $\frac{a}{b}$, where a & b are integers and b (denom) $\neq 0$

ie. $Q = \left\{\frac{a}{b} \middle| a, b \in \mathbb{Z}, b \neq 0\right\}$ (includes repeating decimals)

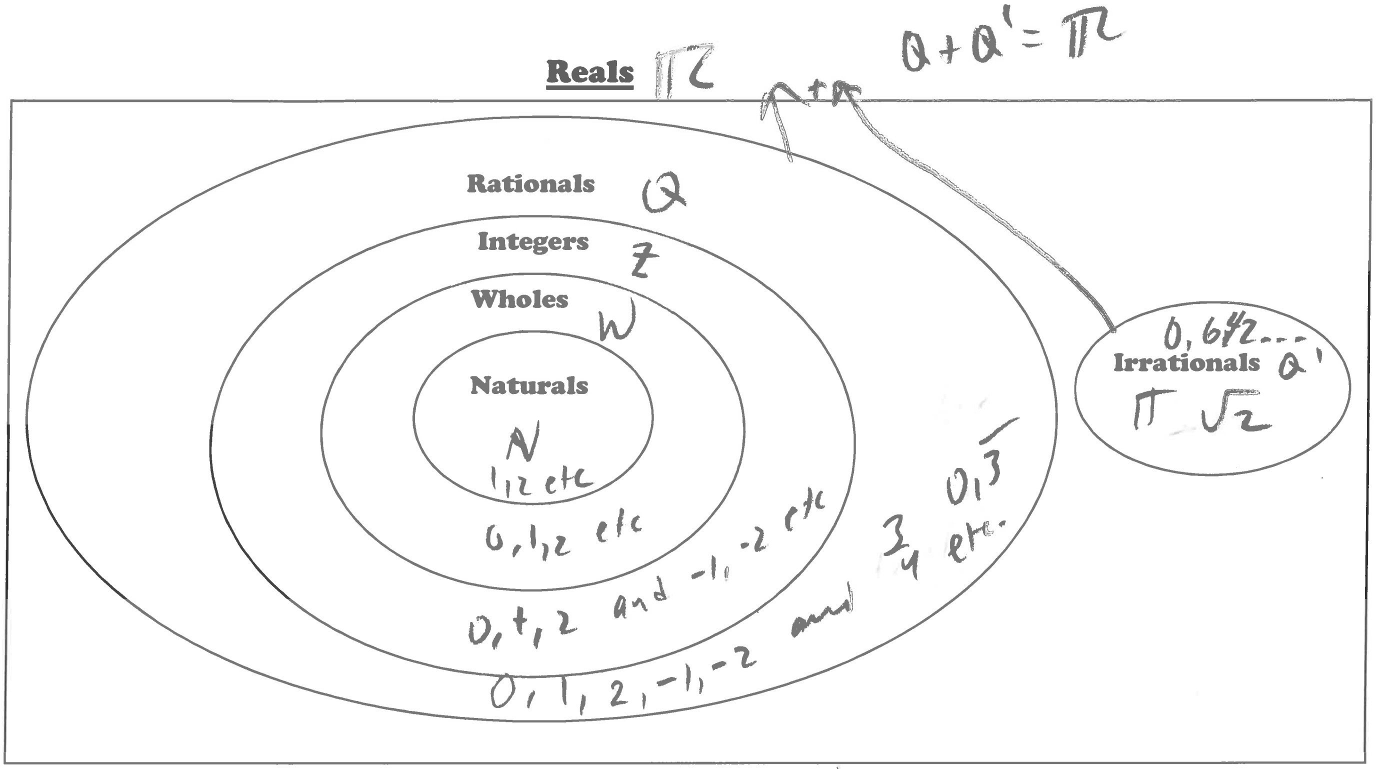
Irrational numbers, Q' or $\bar{Q}$ or I or Ir!, are any number that cannot be written in the form $\frac{a}{b}$, where a & b are integers and b ≠ 0. (includes non-repeating decimals)

Q' = Set of irrational numbers

Real numbers, ℝ, are the Union of the rational number set and the irrational number set.

ie. $\boxed{R = Q \cup Q'}$

(In basic mathematics, **a number divided by zero** isn't a number. **It isn't rational or irrational.** We call it "undefined". On your calculator, dividing by zero gives you an "error".)



(They're all Real!)

Examples: 1. Which Number System *best* represents the following numbers (ie in which number system does it first appear?)

a) 2 N

b) 0.25 Q $\frac{25}{100}$

c) $\sqrt{35}$ Q' √not perfect square
5.9160...

d) -5 Z

repeating decimals can be written as fractions

e) π Q'

f) 0.131313... Q
$= \frac{13}{99}$

g) $\sqrt{25}$ = 5 N

h) 0 W

i) 0.123456789... Q'
no repetition

j) $\frac{3}{4}$ Q

f) $100x = 13.1313...$
$x = 0.1313...$
subtract
$\frac{99x}{99} = \frac{13}{99}$
$x = \frac{13}{99}$

10 PC
Chapter 4

100th if needed

2. Write each number in decimal form (round to 2 decimal places). Some may already be written in decimal form.

a) 3 ___3___

b) 0.41 ___0.41___

6.708 ← 5 or bigger
change to

biggest

c) $\sqrt{45}$ ___6.71___

d) -3 ___-3___ smallest

don't change
less than 5

e) π ___3.14___

f) 0.171717... ___0.17___

g) $\sqrt{16}$ ___4___

h) 0 ___0___

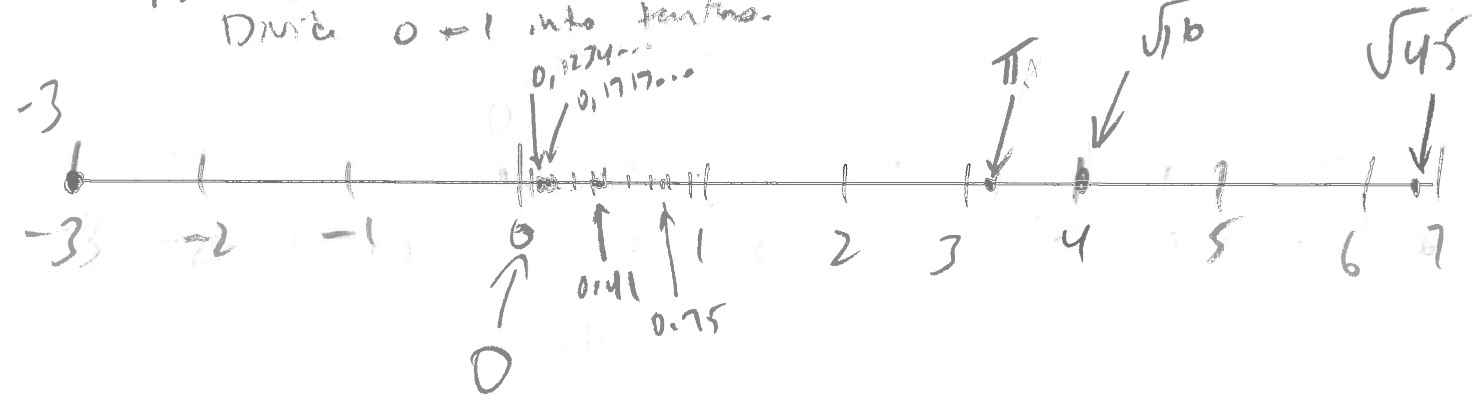
i) 0.123456789... ___0.12___

j) $\frac{3}{4}$ ___0.75___

Use the decimals above to help you

Place the original numbers from above (not the decimal numbers) on a horizontal number line (below). Clearly label the number line and use an appropriate scale.

Fill up the space - evenly spaced intervals.
Put a dot on line. Draw arrow to point.
Divide 0 → 1 into tenths.



HW p. 211 #6, 7, 8, 9, 11, 14, 15

Roots and Cubes

A number that has <u>two equal factors</u> is called ***perfect square.*** (example *7 x 7 = 49*, and therefore *49* is a perfect square). **ONE of the equal factors** is called the ***square root*** of that number. So because 49 = *7 x 7, then 7 is ONE of the equal factors.. and therefore is the square root of 49.*

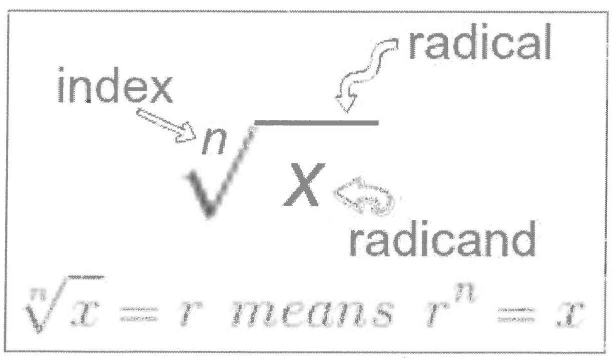
Similarly, a number that is multiplied by itself *three* times to produce a ***perfect cube*** number is called the ***cube root*** of that number. *For example, if 5 x 5 x 5 = 125, then 125 is a perfect cube and the cube root of 125 is 5.*

The mathematical symbol used to represent a **square root** is: $\sqrt[2]{}$ or just $\sqrt{}$

The mathematical symbol used to represent a **cube root** is: $\sqrt[3]{}$

Write the symbol for a fourth root: ________________

Vocabulary:



exponent button
+
fraction button

Practice using your calculator:

Radical	Value	Is the Value Exact or Approximate?
$\sqrt{16}$	4	Exact $16 = 4(4) \therefore \sqrt{16} = 4$
$\sqrt{27}$	5.1962...	Approximate
$\sqrt{\frac{16}{81}}$	$\frac{4}{9}$ or $0.\overline{4}$	Exact $\frac{16}{81} = \frac{4}{9} \cdot \left(\frac{4}{9}\right) \therefore \sqrt{\frac{16}{81}} = \frac{4}{9}$
$\sqrt{0.64}$	0.8	E
$\sqrt[3]{16}$	2.519...	A
$\sqrt[3]{27}$	3	E $27 = 3 \cdot 3 \cdot (3) \therefore 3 = \sqrt[3]{27}$
$\sqrt[3]{\frac{16}{81}}$	0.5823...	A
$\sqrt[3]{0.64}$	0.8617...	A
$\sqrt[3]{-0.64}$	-0.8617...	A
$\sqrt[4]{16}$	2	E $16 = 4 \cdot 4 \cdot 4 (4) \therefore 4 = \sqrt[4]{16}$
$\sqrt[4]{27}$	2.279...	A
$\sqrt[4]{\frac{16}{81}}$	$\frac{4}{3}$	E $\frac{16}{81} = \left(\frac{2}{3}\right)\left(\frac{2}{3}\right)\left(\frac{2}{3}\right)\left(\frac{2}{3}\right) \therefore \sqrt[4]{\frac{16}{81}} = \frac{2}{3}$
$\sqrt[4]{0.64}$	0.9889...	A

So far, all examples have looked at perfect square and cube numbers with whole number (positive integer) roots. However, **roots may be negative integers as well.** "plus or minus 7"

Example: *7 x 7 = 49* and *-7 x -7 = 49*

Therefore, the square root of *49* may be *7* or *-7*, and expressed as: $\sqrt{49} = \pm 7$

Because perfect square numbers are ***always*** positive numbers, you **cannot take the square root of a negative number**. So, $\sqrt{-169}$ does not have a real number solution.

What happens when you cube a negative number?

Example: *(-3) (-3) (-3) = -27*

The **product of three negative numbers is also a negative number**. Therefore, it is possible to find the **cube root of a negative number**, as well as of positive numbers.

So: $\sqrt[3]{-27} = -3$ and $\sqrt[3]{27} = 3$

Homework for tomorrow: ____________________________

4.3 - WRITING MIXED RADICALS AS ENTIRE RADICALS (p. 213)

Radical	Process used	Answer in Simplest Form
$4\sqrt{3}$	$=\sqrt{16}\cdot\sqrt{3} = \sqrt{16\cdot 3}$ $\uparrow$ $\sqrt{4^2}$	$= \sqrt{48}$
$7\sqrt{3}$	$=\sqrt{49}\cdot\sqrt{3} = \sqrt{49\cdot 3}$ $\uparrow$ $\sqrt{7^2}$	$= \sqrt{147}$
$3\sqrt[3]{2}$	$\sqrt[3]{27}\cdot\sqrt[3]{2} = \sqrt[3]{27\cdot 2}$ $\uparrow$ $\sqrt[3]{3^3}$	$= \sqrt[3]{54}$
$4\sqrt{2}$	$=\sqrt{16}\cdot\sqrt{2} = \sqrt{16\cdot 2}$ $\uparrow$ $\sqrt{4^2}$	$= \sqrt{32}$

Explain the process in your own words...

Convert the whole # to an equivalent radical. Then multiply the 2 radicals together to get an entire radical.

Square the # and put under $\sqrt{\ }$ sign or cube the # and put under $\sqrt[3]{\ }$ sign.

$\sqrt{\#\text{ squared}} = \#$ ex. $\sqrt{2^2} = 2$

$\sqrt[3]{\#^3} = \#$ $\sqrt[3]{2^3} = 2$

perfect $\sqrt{\ }$
2^2 4, 3^2 9, 4^2 16, 5^2 25, 6^2 36, 7^2 49, 8^2 64, 9^2 81, 10^2 100

perfect $\sqrt[3]{\ }$
2^3 8, 3^3 27, 4^3 64, 5^3 125

4.3 - WRITING RADICALS IN SIMPLEST FORM (as <u>mixed</u> radicals)

Radical	Process used	Answer in Simplest Form
$\sqrt{80}$	$= \sqrt{16 \cdot 5}$ (4^2) $= \sqrt{16} \cdot \sqrt{5}$ ($\uparrow 4$)	$= 4\sqrt{5}$
$\sqrt{24}$	$\sqrt{4 \cdot 6}$ (2^2) $= \sqrt{4} \cdot \sqrt{6}$ ($\uparrow 2$)	$= 2\sqrt{6}$
$\sqrt[3]{24}$	$= \sqrt[3]{8 \cdot 3}$ (2^3) $= \sqrt[3]{8} \cdot \sqrt[3]{3}$ ($\uparrow 2$)	$= 2\sqrt[3]{3}$
$\sqrt{48}$	$= \sqrt{16 \cdot 3}$ (4^2) $= \sqrt{16} \cdot \sqrt{3}$ ($\uparrow 4$)	$4\sqrt{3}$

Explain the process in your own words...

- Think of biggest perfect square that is a factor of the #. Under the $\sqrt{\ }$ sign, write the perfect square times the remainder to equal the original #.
- Then find the $\sqrt{\ }$ of the perfect square multiplied by $\sqrt{\ }$ of other #.

* Similar process for $\sqrt[3]{\ }$. Find largest perfect cube. etc.

Try these:

1. Simplify each radical / write each radical in simplest form (as a mixed radical), **if possible**. (If not possible, write 'cannot be simplified'. (see p. 8)

(This means the **radical** will contain no factors that can be written as the power of the index, *other than 1.*

Write the radicand as a **product of 2 factors**, one of which is the **greatest perfect power of the nth power** (the index). (see p. 5 for vocabulary).

If you're having problems coming up with the largest perfect square, cube, 4th power etc.. try **writing the number as a product of prime factors.** For the square root, write the prime factors in two equal groups of two. Multiply the numbers in one group. For the cube root, similarly write the factors in groups of three. (etc.)

a) $\sqrt{80}$

$\sqrt{16} \cdot \sqrt{5}$

$= 4\sqrt{5}$

b) $\sqrt[3]{144}$

$\sqrt[3]{8} \cdot \sqrt[3]{18}$

$= 2\sqrt[3]{18}$

c) $\sqrt[4]{162}$

$= \sqrt[4]{81} \cdot \sqrt[4]{2}$

$= 2\sqrt[4]{2}$

2. Write each mixed radical as an **entire radical**. (see p. 7)

a) $\sqrt[3]{40}$

$= \sqrt[3]{8} \cdot \sqrt[3]{5}$

$= 2\sqrt[3]{5}$

b) $\sqrt{26}$

cannot be simplified

26

2 13

c) $\sqrt[4]{32}$

$= \sqrt[4]{16} \cdot \sqrt[4]{2}$

$= 2\sqrt[4]{2}$

Homework for tomorrow: ___________________________

4.4 – FRACTIONAL EXPONENTS AND RADICALS (p. 222)

Directions: **Work with a partner and complete the table.** Use a calculator to complete the second column. (Use your exponent button and your fraction button.)

X	$x^{\frac{1}{2}}$	x	$x^{\frac{1}{3}}$
1	1	1	1
4	2	8	2
9	3	27	3
16	4	64	4
25	5	125	5

1. What do you notice about the numbers in the first column?

perfect squares

2. Compare the numbers in the first and second columns. What conclusions can you make? The #s in second column are $\sqrt{\ }$ of #s in 1st column

3. What do you think the exponent $\frac{1}{2}$ means?

$\sqrt{\ }$

4. What do you think the exponent $\frac{1}{3}$ means?

$\sqrt[3]{\ }$

5. What do you think $a^{\frac{1}{4}}$ and $a^{\frac{1}{5}}$ mean?

$\sqrt[4]{\ }$ $\sqrt[5]{\ }$

6. What does $a^{\frac{1}{n}}$ mean? Explain.

$\sqrt[n]{\ }$

$\boxed{\text{denominator of fractional exponent}} = \boxed{\text{index of radical}}$

4.4 Evaluating Powers of the Form $x^{\frac{1}{n}}$ p. 222

The ***product law*** states: when multiplying powers with the **same** base, **add** the exponents

$\boxed{x^m \bullet x^n = x^{m+n}}$ For example, $5^2 \bullet 5^3 = 5^{2+3} = 5^5$

This law can be extended to powers with ***fractional exponents with a numerator of 1***

$x^{\frac{1}{2}} \bullet x^{\frac{1}{2}} = x^{\frac{1}{2}+\frac{1}{2}} = x^1$ For example, $5^{\frac{1}{2}} \bullet 5^{\frac{1}{2}} = 5^{\frac{1}{2}+\frac{1}{2}} = 5^1$

Similarly, $x^{\frac{1}{3}} \bullet x^{\frac{1}{3}} \bullet x^{\frac{1}{3}} = x^{\frac{1}{3}+\frac{1}{3}+\frac{1}{3}} = x^1$ For example, $5^{\frac{1}{3}} \bullet 5^{\frac{1}{3}} \bullet 5^{\frac{1}{3}} = 5^{\frac{1}{3}+\frac{1}{3}+\frac{1}{3}} = 5^1$

Therefore: $x^{\frac{1}{2}}$ is equivalent to $\sqrt{x}$, example $5^{\frac{1}{2}}$ is equivalent to $\sqrt{5}$, and

$x^{\frac{1}{3}}$ is equivalent to $\sqrt[3]{x}$, example $5^{\frac{1}{3}}$ is equivalent to $\sqrt[3]{5}$

- *The **base of the power** is the same as the **radicand of the radical***
- *The **denominator of the exponent** is the **index of the radical***
- *Raising a number to the **exponent** $\frac{1}{2}$ is equivalent to taking its **square root***
- *Raising a number to the **exponent** $\frac{1}{3}$ is equivalent to taking its **cube root**, and so on*

1. Powers with Rational Exponents with a Numerator of 1 p. 224

When 'n' is a natural number and 'x' is a rational number, $\boxed{x^{\frac{1}{n}} = \sqrt[n]{x}}$

Example: Evaluate each of the following powers .
(***The denominator*** *of the exponent is the* ***index*** *of the* ***radical.)***

a) $27^{\frac{1}{3}}$

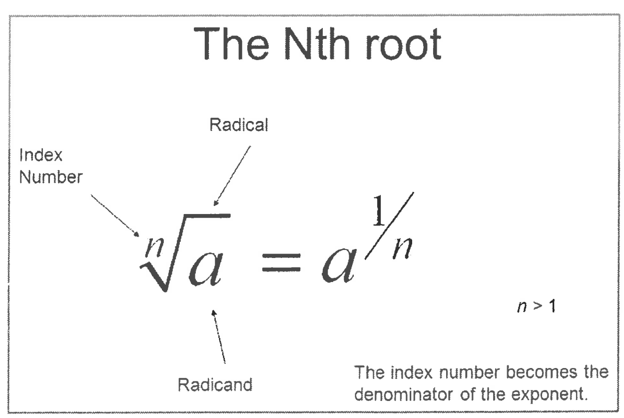
$= \sqrt[3]{27} = 3$

b) $0.49^{\frac{1}{2}}$

$= \sqrt{0,49}$

$= \sqrt{\frac{49}{100}}$

$= \frac{7}{10} = 0,7$



c) $(-64)^{\frac{1}{3}}$

$= \sqrt[3]{-64}$

$= -3$

d) $\left(\frac{4}{9}\right)^{\frac{1}{2}}$

$= \sqrt{\frac{4}{9}}$

$= \frac{\sqrt{4}}{\sqrt{9}}$

$= \frac{2}{3}$ ← * fraction

2. *Rewriting Powers in Radical and Exponent Form* (p. 225)

NOTE: A fraction can be written as a *terminating or repeating decimal*, so powers with decimal exponents can be interpreted. For example, $\boxed{0.2 = \frac{1}{5},\text{ therefore } 32^{0.2} = 32^{\frac{1}{5}}}$

> The ***power law*** states: *when raising a power to an exponent,* ***multiply*** *the exponents*
>
> $(x^m)^n = x^{mn}$ *where 'm' and 'n' are rational numbers.* For example, $(8^2)^3 = 8^{2 \times 3} = 8^6$

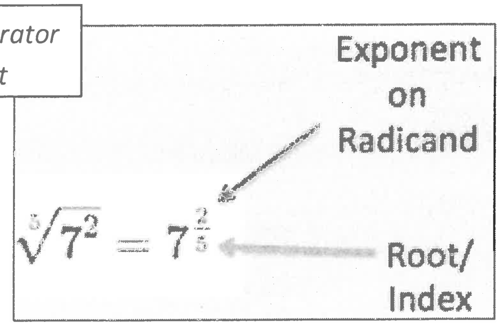
An extension of the power law can be made. For example, an exponent is a fraction with a ***numerator greater than one***, such as $\frac{2}{3}$, it can be written as $(\frac{1}{3})(2)$

For example, $\boxed{8^{\frac{1}{3} \bullet 2} \textit{ which is the same as } (8^{\frac{1}{3}})^2.}$

Now a ***fractional exponent with a numerator of 1*** has been created, similar to what was previously done. Therefore, *the denominator of the exponent is the index of the radical, 'x' is the radicand, and* ***the exponent is carried down.***

For example, $\boxed{(8^{\frac{1}{3}})^2 \textit{ can be written as, } (\sqrt[3]{8})^2 \textit{ or } \sqrt[3]{8^2}.}$ Solve using ***both*** methods.

denominator first →	$= 2^2$	$= \sqrt[3]{64}$	*numerator ←first*
	$= 4$	$= 4$	



When 'm' and 'n' are natural numbers and 'x' is a rational number:

$$\boxed{x^{\frac{m}{n}} = (x^{\frac{1}{n}})^m = (\sqrt[n]{x})^m = \sqrt[n]{x^m}}$$

Therefore:

- *The* ***numerator*** *of a fractional exponent represents a* ***power***
- *The* ***denominator*** *of a fractional exponent represents a* ***root***
- ***'x' is the radicand***
- ***The root and power can be evaluated in any order***

Try it:

a) Write $40^{\frac{2}{3}}$ in radical form in ***two*** ways

$\sqrt[3]{40^2}$ or $(\sqrt[3]{40})^2$

b) Write $(\sqrt[3]{25})^2$ *and* $\sqrt{3^5}$ in exponent form

$= 25^{\frac{2}{3}}$ $\quad = 3^{\frac{5}{2}}$

memorize perfect squares, cubes, fourths up to at least value of 100

3. Evaluating Powers with Rational Exponents and Rational Bases (p. 225)

$1\frac{8}{10} = \frac{18}{10}$

Show ALL steps in the way that you could find these answers without a calculator.

parenthesis important!

Examples: a) $0.04^{\frac{3}{2}}$ b) $27^{\frac{4}{3}}$ c) $(-32)^{0.4}$ d) $1.8^{1.4}$

a) $= \left(\sqrt{\frac{4}{100}}\right)^3 = \left(\frac{2}{10}\right)^3 = \frac{8}{1000} \leftarrow$ 3 zeros $= 0.008$

b) $= \left(\sqrt[3]{27}\right)^4 = 3^4 = 81$

c) $= (-32)^{\frac{4}{10}} = (-32)^{\frac{2}{5}} = \left(\sqrt[5]{-32}\right)^2 = (-2)^2 = 4$

d) $1.4 = 1\frac{4}{10} = \frac{14}{10} = \frac{7}{5}$

$= \left(\sqrt[5]{\frac{18}{10}}\right)^7$

need calc.

$1.8^{1.4} = 2.2771$

Try it: (a) 0.001 (b) 81 (c) 27 (d) 0.7080...

a) $0.01^{\frac{3}{2}}$ b) $(-27)^{\frac{4}{3}}$ c) $81^{\frac{3}{4}}$ d) $0.75^{1.2}$

a) $= \left(\sqrt{\frac{1}{100}}\right)^3 = \left(\frac{1}{10}\right)^3 = \frac{1}{1000} = 0.001$

b) $= \left(\sqrt[3]{-27}\right)^4 = (-3)^4 = 81$

c) $= \left(\sqrt[4]{81}\right)^3 = 3^3 = 27$

d) $\frac{12}{10}$ $= \left(\frac{75}{100}\right)$

use calc.

$= 0.7081$

Homework for tomorrow: ______________________________

4.5 – NEGATIVE EXPONENTS AND RECIPROCALS (p. 229)

Use your textbook – pages 229 – 232. Write in complete sentences.

1. Complete this statement: (p. 230 under green box)

   Two numbers with a product of 1 are reciprocals.

Example: Since $4 \cdot \frac{1}{4} = 1$, the numbers 4 and $\frac{1}{4}$ are reciprocals.

2. Write **example 1a** on page 231. Identify the **base**. Identify the **exponent**.

   3^{-2} ← exp.

   base

3. Look at the **solution** to example 1a. **Describe the location of the base. What happened to the sign** on the **exponent**?

   $3^{-2} = \frac{1}{3^2} = \frac{1}{9}$

   neg. pos.

   went to denominator

4. **Read examples 1b and 1c.** Do you understand them? If not, read them again. **Identify** the parts that confuse you.

   $\left(-\frac{3}{4}\right)^{-3}$

   $= \left(-\frac{4}{3}\right)^{3}$ ← pos.

   $= -\frac{64}{27}$

   reciprocal

   0.3^{-4}

   $= \frac{1}{0.3^4}$

   but we don't put decimal in fraction, use calc.

5. **Read** the rule for Powers with Negative Exponents found on the top of page 231. Write it down.

$x^{-n} = \frac{1}{x^n}$ $\quad \frac{1}{x^{-n}} = x^n$, $x \neq 0$

n is rational

6. Complete "check your understanding question" #1 on page 231. Check your answers.

$7^{-2} = \frac{1}{7^2} = \frac{1}{49}$

$\left(\frac{10}{3}\right)^{-3} = \left(\frac{3}{10}\right)^3 = \frac{27}{1000}$

$(-1.5)^{-3} = -0.2963$

CHECKPOINT – STOP HERE for further instruction.

7. Read example 2 on page 231. Do you understand them? If not, read them again. **Identify** the parts that confuse you.

$8^{-\frac{2}{3}} = \frac{1}{8^{\frac{2}{3}}} = \frac{1}{(\sqrt[3]{8})^2} = \frac{1}{2^2} = \frac{1}{4}$

$\left(\frac{9}{16}\right)^{-\frac{3}{2}} = \left(\frac{16}{9}\right)^{\frac{3}{2}} = \left(\sqrt{\frac{16}{9}}\right)^3 = \left(\frac{4}{3}\right)^3 = \frac{64}{27}$

① reciprocal of #
② radical with denom of fractional exponent = index, numerator = exponent

8. Complete "check your understanding question" #2 on page 232. Check your answers.

$16^{-\frac{5}{4}} = \left(\frac{1}{16}\right)^{\frac{5}{4}} = \left(\sqrt[4]{\frac{1}{16}}\right)^5 = \left(\frac{1}{2}\right)^5 = \frac{1}{32}$

$\left(\frac{25}{36}\right)^{-\frac{1}{2}} = \left(\frac{36}{25}\right)^{\frac{1}{2}} = \sqrt{\frac{36}{25}} = \frac{6}{5}$

Homework for tomorrow: ______________________________

 see p. 18 exponent laws

4.6 – APPLYING THE EXPONENT LAWS p. 237

Under the "think" column, **individually simplify the expression.** When prompted to do so, with a partner, explain (using words) the process you used. As a class we will share our responses. You can use this column to jot down additional notes.

Think	Explain	Share
$\dfrac{x^{\frac{5}{4}} \bullet x^{\frac{-1}{4}}}{x^{\frac{3}{4}}}$ $= x^{\frac{5}{4}-\frac{1}{4}-\frac{3}{4}}$ $= x^{\frac{1}{4}}$	• add exponents when multiplying same variables • subtract exponents when dividing same variable • add/subtract fractions → add/subtract num; don't change denom.	
$\dfrac{12x^{-5}y^{\frac{5}{2}}}{3x^{\frac{1}{2}}y^{\frac{-1}{2}}}$ $4x^{-5-\frac{1}{2}}y^{\frac{5}{2}-(-\frac{1}{2})}$ $= 4x^{-\frac{10}{2}-\frac{1}{2}}y^{\frac{5}{2}+\frac{1}{2}}$ $= 4x^{\frac{-11}{2}}y^{\frac{6}{2}}$ $= 4x^{\frac{-11}{2}}y^{3}$ ← write with all values in numerator. $= \dfrac{4y^3}{x^{\frac{11}{2}}}$ ← write with pos. exponents	Same as above and ... subtracting fractions: change to equivalent fractions with common denominator	

Think	Explain	Share
$(m^4n^{-6})(m^2n^3)$ $= m^6 n^{-3}$ $= m^6 \cdot \frac{1}{n^3}$ $= \frac{m^6}{n^3}$	- add exponents of same letter - negative exponent goes in denom.	
$(25a^4b^2)^{\frac{3}{2}}$ $= 25^{\frac{3}{2}} a^{\frac{12}{2}} b^{\frac{6}{2}}$ $= (\sqrt{25})^3 a^6 b^3$ $= 5^3 a^6 b^3$ $= 125 a^6 b^3$	distribute $\frac{3}{2}$ to coefficient and each variable (for each variable, multiply by exponent that is there)	

The Exponent Laws

Remember the exponent laws:

- Product Law: $a^m \times a^n = a^{m+n}$ OR $5^3 \times 5^2 = 5^{3+2} = 5^5$
- Quotient Law: $a^m \div a^n = a^{m-n}$ OR $5^3 \div 5^2 = 5^{3-2} = 5^1$
- Power Laws:

  i) $(a^m)^n = a^{mn}$ OR $(5^3)^2 = 5^6$

  ii) $(ab)^m = a^m b^m$

  iii) $(\frac{a}{b})^m = \frac{a^m}{b^m}$

Try these:

a) $0.3^{-3} \times 0.3^5$

0.3^2

$= 0.09$

b) $[(-\frac{3}{2})^{-4}]^2 \times [(-\frac{3}{2})^2]^3$

$= \left(-\frac{3}{2}\right)^{-8} \cdot \left(-\frac{3}{2}\right)^{6}$

$= \left(-\frac{3}{2}\right)^{-2} = \left(-\frac{2}{3}\right)^{2} = \frac{4}{9}$

c) $\frac{1.4^3 \times 1.4^4}{1.4^{-2}}$

$= \frac{1.4^7}{1.4^{-2}}$

$= 1.4^{7-(-2)}$

$= 1.4^9$

$= 20.6610$

d) $\left(\frac{7^{2/3}}{7^{1/3} \times 7^{5/3}}\right)^6$

BEDMAS
↑
first

$= \left(\frac{7^{\frac{2}{3}}}{7^{\frac{6}{3}}}\right)^6$

$= \left(7^{-\frac{4}{3}}\right)^6$

$= 7^{-\frac{24}{3}}$

$= 7^{-8}$

$= \left(\frac{1}{7}\right)^8$

$= \frac{1}{5\,764\,801}$

Use the exponent laws to try the following:

a) $(x^3y^2)(x^2y^{-4})$

x^5y^{-8}

$= x^5 \cdot \frac{1}{y^8}$

$= \frac{x^5}{y^8}$

b) $(m^4n^{-2}) \div (m^2n^3)$

$= m^2n^{-5}$

$= \frac{m^2}{n^5}$

c) $(10a^5b^3)(2a^2b^{-2})$

$= 20a^7b$

d) $(6x^4y^{-3}) \div (14xy^2)$

$= \frac{6}{14}x^3y^{-5}$

$= \frac{3x^3}{7y^5}$

e) $(c^3d^2)^{-4}$

$= c^{-12}d^{-8}$

$= \frac{1}{c^{12}d^8}$

f) $(8a^3b^6)^{1/3}$

$= \sqrt[3]{8}\, a^{3 \cdot \frac{1}{3}}\, b^{6 \cdot \frac{1}{3}}$

$= 2ab^2$

g) $(x^{2/3}y^2)(x^{1/2}y^{-1})$

$= x^{\frac{2}{6}}y^{-2}$

$= \frac{x^{\frac{1}{3}}}{y^2}$

h) $(4a^{-2}b^{2/3}) \div (2a^2b^{1/3})$

$= 2a^{-4}b^{\frac{2}{9}}$

$= \frac{2b^{\frac{2}{9}}}{a^4}$

Homework : ______________________________